Step 1

- Complete the Felder and Brent Learning Styles Inventory at [http://www.engr.ncsu.edu/learningstyles/ilsweb.html](http://www.engr.ncsu.edu/learningstyles/ilsweb.html)
  (more information at [http://educationdesignsinc.com/index-of-learning-styles](http://educationdesignsinc.com/index-of-learning-styles))
- Do not worry too much about getting the “right” answer!
- Tally up your scores in the table at the end if you are working on a paper copy (done automatically if you are on-line)
- When you have your score, put it on the podium at the front, or enter it on the board.
Teaching Fish When You are a Penguin...

Suzanne Kresta
January, 2017

http://www.wimp.com/beingpenguins/
Today’s Learning Objectives

• Know your own preferred learning styles, and those of your students. Understand how this impacts student learning and course design.  

• Identify examples of teaching strategies designed to address different learning styles.

• Validate differences in thinking patterns between expert and novice learners.

• Leave with curiosity about structured problem solving tools...and references to support further explorations.
Step 1

- Complete the Felder and Brent Learning Styles Inventory (available on-line at http://www.engr.ncsu.edu/learningstyles/ilsweb.html)
- Do not worry too much about getting the “right” answer!
- Tally up your scores in the table at the end (done automatically if you are on-line)
- When you have your score, put it on the podium at the front.
- We won’t go to the next page until we have all the scores!
Step 2: Who are we?

- Visual or
- Sequential or
- Active or
- Sensing or
- Verbal
- Global
- Reflective
- Intuitive
Normalize the Data

• Scale goes from
  \textbf{Visual} 11,9,7,5,3,1 to 1,3,5,7,9,11 Verbal
    – Weight 11 as 5, 9 as 4, 7 as 3, 5 as 2, 3 as 1, and 1 as 0 for each of the scales
    – Multiply by the number of responses in each bin
    – Add up the sub-total for Visual and the sub-total for Verbal
• Normalize the scores e.g.

\[
\text{Visual} = \frac{\text{Visual}}{(\text{Visual} + \text{Verbal})} \times 10
\]
Step 2: Who are we?

- Visual
- Sequential
- Active
- Sensing
- Verbal
- Global
- Reflective
- Intuitive

What does this mean?
See the handout from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm and Felder’s website for more information.
Step 3: Who are our students?
(Engineering) Students tend to be sequential learners.

• Professors prefer **global** learning (3.5 (students) vs. 6.5 (profs))

• Sequential learners tend to
  – Gain understanding in linear steps, with each step following logically from the previous one.
  – Follow logical stepwise paths in finding solutions.

• Global learners tend to
  – Need the big picture of a subject before they can master details.
  – They may be able to solve complex problems quickly or put things together in novel ways once they have grasped the big picture.
  – They may also have difficulty explaining how they did it.

*Examples open the door between these learning styles!*

http://www.youtube.com/watch?v=XZm6y0ALDCc
Identify Teaching Strategies

For each of the activities we just did, identify the learning style or styles that engage:

• Provide learning objectives
• Complete the survey
• Compare data with student results
• Videos of penguins
• Discussion of learning styles
Identify Teaching Strategies

• Provide learning objectives – global and sequential
• Complete the survey - active, sensing
• Compare data with student results – sensing, visual, reflective
• Discussion of learning styles – active, verbal, sensing, reflective, global
• Building up the story one step at a time – sequential
• Videos of penguins – visual, intuitive, affective 5 - empathy
What is wrong with this picture?

FOR A FAIR SELECTION EVERYBODY HAS TO TAKE THE SAME EXAM: PLEASE CLimb THAT TREE
Some questions

• If our goal is to have students learn, does it make sense to adapt our teaching style to their learning style?
  – corollary: Would you design a bridge to withstand $g$ on the moon if it is being built on earth?

• How can we best do this?
  – see the Exploring Examples slides and video

• Is there another interpretation of the data?
  – with thanks to Dr Sigurdson (MecE) and Dr Gauthier (CTL)
Universal Design of Instruction

Equal and “fair”

In the first image, it is assumed that everyone will benefit from the same supports. They are being treated equally.

Equitable or “Level Playing Field”

In the second image, individuals are given different supports to make it possible for them to have equal access to the game. They are being treated equitably.

Robust and Accurate or “Barrier Free Design”

In the third image, all three can see the game without any supports or accommodations because the cause of the inequity was addressed. The systemic barrier has been removed.
Summary – Learning Styles

• Since the original inventory was developed, a number of other learning styles have been proposed.

• Like personality typing, there is no one right answer – except that people are different!

• Replace the Golden Rule with the Platinum Rule: Treat others the way they want to be treated!
The Golden Rule
Love thy neighbor

The Platinum Rule
Never ever, ever, ever, ever love thy neighbor
The Platinum Plus Rule

Treat other people the way their best self would want your best self to treat them

Diane Windingland, SmallTalkBigResults.com
Summary – Learning Styles

• Since the original inventory (ILS) was developed, a number of other learning styles have been proposed.
• Like personality typing, there is no one right answer – except that people are different!
• Replace the Golden Rule with the Platinum Rule: Treat others the way they want to be treated!
• Teaching only the way students want to learn limits their growth; Teaching them only the way we want to learn limits their learning.
• Consistent result: A varied approach works best.
Some Examples*

• *Teach theoretical material by first presenting phenomena and problems that relate to the theory* (sensing, inductive, global).

• *Use of sketches, plots, schematics, and videos (visual) in addition to oral and written explanations (verbal).*

• *Discuss the flow of topics (sequential), and connections to other courses, and to everyday experience (global).*

• *Encourage or mandate cooperation on homework* (every style category). Hundreds of research studies show that students who participate in cooperative learning experiences earn better grades, display more enthusiasm, and improve their chances for graduation. Note: be clear about expectations!

*Extracted from Felder, ASEE Prism, 6(4), 18-23 (December 1996).*
Another way to think about this: Expert vs. Novice

Experts

• Have built an extensive, well-organized system of knowledge
• This is their foundation for remembering, reasoning and problem-solving.
• AND organizing and interpreting new information.
• *It allows them to draw on relevant information quickly and flexibly when understanding new situations or solving new problems.*

Novices

• Do not know what ideas are important yet, so they cannot easily organize their growing knowledge.
• Often have a large, unstructured bank of knowledge which they randomly access to retrieve information.
• The relevance of knowledge to a new question or problem is unclear, and even mysterious!

http://duke.edu/arc/faculty_staff/student_learning/experts_vs_novices.php
What do experts do when they learn?

- Pose questions to themselves
- Can separate relevant information from irrelevant information.
- Respond to context
- Recognize meaningful patterns and connections
- Organize knowledge around key principles and concepts.

- Self-regulate their time and efforts including goal setting, time management, self-evaluation, self-motivation.
- Self-motivate
- Remain flexible in thinking, adapting to changing needs.
Bridging the Gap from Novice to Expert – What Works?

- **Core Concepts and Experiences** – share learning objectives and key outcomes, provide examples organized around the big ideas, show application of the same idea in several contexts
- **Task Analysis** – share the key questions needed to diagnose the problem and structure a solution
- **Pattern Recognition** - learners must be able to see how ideas are connected (provide concept maps – see CTL workshop)
- **Metacognition** – develop an awareness of their own thinking and behaviors (e.g. administer learning styles, provide CATME team rubric)
- **Self-regulation** – let them know that frustration is normal and they are moving up the cognitive scale every year in the program
Learning Objectives – check progress

• Know your own preferred learning styles, and those of your students. Understand how this impacts student learning and course design. *know and affective 1 - respect differences*
• Identify examples of teaching strategies designed to address different learning styles. *understand*
• Validate differences in thinking patterns between expert and novice learners. *apply*
• Leave with curiosity about structured problem solving tools...and references to support further explorations.
Problem Solving

Experts

• Classify problems based on deep structure
• Structure knowledge and interconnections
• Start with general equations
• Problem solving is a process
• Draw analogies

Novices

• Focus on surface features
• Knowledge is randomly organized
• Start with many specific equations
• Problem solving is a recall task
• Interpret literally
Problem Solving Strategies
Fogler and LeBlanc, Strategies for Creative Problem Solving, 3rd ed. 2013 – TEXTBOOK!
D.R. Woods, An Evidence Based Strategy for Problem Solving,

1. Engage – self-regulation
2. Define
3. Explore
4. Plan
5. Do it
6. Look Back – Critically Evaluate the Results

See handout for more details. Share this information!
This is now taught explicitly in medicine and business.
Strategic Problem Solving

1. Engage and Motivate
2. Define and Align (with vision and values)
3. Get Clarity (what would be an outstanding result?)
4. Explore and Create Possibilities
5. Refine, Plan the Process and Identify Critical Gates
6. Execute and Iterate
7. Review, Debrief, and Celebrate!

(Kresta, 2011)
Conclusion

• Know your own preferred learning styles, and those of your students. Understand how this impacts student learning and course design.

• Use teaching strategies designed to address different learning styles.

• Structure expectations for students as novice learners.

• Leave with curiosity about structured problem solving tools...and references to support further explorations.

  affective 2 – engage and respond

Notice the way active learning worked today – time, structure, focussed objectives!
Experts vs Novices: What Students Struggle with Most in STEM Disciplines

“Students know far less when they emerge from courses than most faculty think they do.” This was a finding from an NSF funded project on assessing student achievement in undergraduate science, technology, engineering and mathematics (STEM) courses.

Results from this multi-university survey indicate that:

- Faculty are generally not aware of little their students get, and thus tend to test in such a way as to never find out.
- Classroom instruction has remarkably little effect on test scores.
- What faculty teach, despite their best efforts, is not what students learn or how they learn.
- Summative assessment without formative assessment does not give faculty a true indication of student ability.
- Students can master exams successfully without successfully mastering disciplinary concepts.
- Student achievement can be increased with effective assessment.
- Assessing student understanding of key concepts takes more than just knowing whether they can produce the right answers to problems.
- No matter how advanced your students are, do not assume they have conceptual knowledge about the most basic concepts.
- Transfer of learning between courses is close to non-existent for many students and yet there are research-based methods to address this issue.
- Formative assessment, integrated with peer teaching in large lecture courses, can dramatically improve learning.
- Active/collaborative/interactive pedagogies are documented to provide greater gains in student learning.
- Rubrics are valuable tools in informing students about expectations for their learning and about the ways in which their learning will be measured.
- Students do not learn if they are expected to ‘feedback’ only what is in the book (or in their notes).

This Assessment of Student Achievement (ASA) project is one of many initiated by Project Kaleidoscope (www.pkal.org), one of the leading advocates in the United States for building and sustaining strong undergraduate programs in the fields of science, technology, engineering and mathematics (STEM).

These results seem to indicate a troubling disconnect between how students (novice learners in the discipline), learn and understand their course material and how faculty (expert learners in the discipline) traditionally approach and teach this material. Possible reasons for this disconnect become clearer when we look at what differentiates an expert from a novice learner.
What differentiates an ‘expert’ from a ‘novice’?

An expert is someone who has a high degree of proficiency, skill, and knowledge in a particular subject. Experts are able to effectively think about and solve problems. They see patterns in information and are able to identify solutions. Moving from novice to expert involves much more than simply developing a set of generic skills and strategies. Experts develop extensive knowledge that impacts the way they identify problems, organize and interpret data, and formulate solutions. Their approach to reasoning and solving problems is different from that of a novice.

In their report, How People Learn: Brain, Mind, Experience, and School (http://www.nap.edu/html/howpeople1/), Bransford et. al. (1999) identified key principles of experts' knowledge and their potential implications for learning and instruction:

- Experts notice features and meaningful patterns of information that are not noticed by novices.
- Experts have acquired a great deal of content knowledge that is organized in ways that reflect a deep understanding of their subject matter.
- Experts' knowledge cannot be reduced to sets of isolated facts or propositions but, instead, reflects contexts of applicability: that is, the knowledge is "conditionalized" on a set of circumstances.
- Experts are able to flexibly retrieve important aspects of their knowledge with little attentional effort.
- Though experts know their disciplines thoroughly, this does not guarantee that they are able to teach others.
- Experts have varying levels of flexibility in their approach to new situations.

Based on the growing body of research, the following attributes of experts can be identified. Experts:

- Pose useful questions to themselves about the information they are exploring.
- Identify relevant information and ignore irrelevant information.
- Respond to context and select information to address specific needs.
- Recognize meaningful patterns and connections in information.
- Organize knowledge around key principles and concepts.
- Self-regulate their time and efforts including goal setting, time management, self-evaluation, self-motivation.
- Self-motivate through varying their methods of study and practice.
- Remain flexible in thinking, adapting to changing needs.

So, how can faculty/experts help students develop the necessary repertoire of knowledge and range of skills and strategies? Consider some of the following key areas:
• Core Concepts and Experiences - learners need a foundation of knowledge, background information, examples, resources, and varied experiences related to their topic organized around the big ideas

• Task Analysis - learners must develop an understanding of the problem or key questions and be able to prioritize and focus on the key issues

• Pattern Recognition - learners must be able to structure information in meaningful ways and see the how ideas are connected

• Metacognition - learners must be aware of their thinking and flexible enough to adapt to changing needs

• Self-regulation - learners must be able to control their thinking and actions

Content adapted from virtualinquiry.com (http://virtualinquiry.com/scientist/scientist1a.htm)

Selected expert-novice differences in problem-solving:

1. **Experts classify problems based on deep structure, while novices classify based on surface features.** Experts/faculty have a cognitive map of their discipline and tend to grasp the ‘big picture’ easily. Students want to know formulas and equations (“why do I have to know this?”) and want to get it right rather than understand the purpose of the question/problem.
   
   

2. **Expert knowledge is chunked and organized hierarchically (around basic principles), while novice knowledge is more randomly organized (they don’t have the expertise to connect new information they learn to something they already know).**

   
   

3. **Experts start with general equations, while novices start with specific equations.** Novices tend to use a “means-to-an-end” approach, in other words, work backwards (the answer defines they way to solve or approach the problem), while experts work forward, checking logic and answers as they go.

4. *Experts view problem-solving as a process, while novices think it is a recall task.* By the time someone becomes an expert, something that may have been viewed as a “problem” at some point has generally become an “exercise”. Experts can make solving problems look easy, which causes novices to mistakenly think that they should be able to understand and solve problems easily too. When this does not translate in practice, novices generally become frustrated and question their ability. This is a problem that can push many students out of STEM disciplines because they feel they “just don’t get it and never will”.


5. *Experts use qualitative representations extensively, while novices have trouble with representations.*


Content adapted from: “Making Problem Solving a Priority” presented by Kathleen A. Harper, Department of Physics, Ohio State University at the 32nd Annual Conference of the Professional Organization and Development (POD) Network, October 2007, Pittsburgh, Pennsylvania, U.S.A.
Problem Solving Strategies
Fogler and LeBlanc, Strategies for Creative Problem Solving, 3rd ed, 2013
D.R. Woods, An Evidence Based Strategy for Problem Solving,

1. **Engage**
   - focus on solving the problem

2. **Problem Definition**
   - clarify all available information
   - restate the problem: what is known? what is unknown?
   - draw diagrams
   - take notes

3. **Explore Possible Solutions**
   - talk with others: brainstorm
   - collect missing information
   - thought experiments
   - ball park estimates
   - check for errors in logic

4. **Plan a Course of Action**
   - select best approach
   - lay out plan of attack
   - stuck? Take a break!
   - critical path analysis
   - obtain resources

5. **Do it.**

6. **Evaluate the Results**
   - right order of magnitude?
   - viable solution?
   - are all constraints and requirements met?
Characteristics of Expert Problem Solvers
(adapted from ASEE Prism, Oct/96)

Expert problem solvers spend most of their time in the "define" and "explore" stages of the problem. They always evaluate the results. Underlying these actions, they have developed a lot of "mental toughness," (or panic avoidance). Expert problem solvers place a high value on the following approaches:

1. **Accuracy in Reading**
   - focus on the meaning of the problem statement
   - understand every word
   - collect all facts
   - reread the statement several times (at least 3)
   - complete the problem definition before doing any work

2. **Accuracy in Thinking**
   - value accuracy
   - work carefully
   - use words, notation, and procedures consistently
   - check information if unsure
   - work calmly
   - draw conclusions only if warranted

3. **Active Exploration of Possible Solutions**
   - draw sketches
   - think out loud/group think
   - break problem down into parts
   - build from easy solutions to more difficult ones
   - draw on prior knowledge and experience
   - ask questions

4. **Play to Win/Persevere/Believe in Yourself**
   - self confidence
   - self critical - question methods and approaches
   - ground all conclusions thoroughly
   - use a "time out" to regroup for a fresh attack